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## NAMES III Executive Summary

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May 1979

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NAMES III include the patient work load, medical personnel and materiel resources, evacuation resources including ambulances, helicopters, and fixed-wing aircraft, as well as the configuration of the complete medical treatment and evacuation system. Outputs of NAMES III include patient dispositions, including mortalities, measures of morbidity, and the number of patients returned to duty. Measures of resource utilization, short comings and efficiency are also obtained as output from the model.

The purpose of the Executive Summary is to provide new and prospective users a general overview of the model and its capabilities. Information necessary to effectively use the NAMES III program is contained in the User's Manual, NRL Instruction Book 172. The User's Manual discusses three aspects of the NAMES III simulation program. It first describes the NAMES III Model's medical evacuation system including its inputs and outputs. Secondly, it presents instructions for the use of NAMPRP, a program used to prepare NAMES III input data. Finally, the User's Manual contains instructions for the use of the three computer systems on which NAMES III is currently implemented -- the CDC CYBERNET system, the CDC 6000 series system, and the Honeywell 6000 series system.

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## FOREWORD

The original version of the Naval Research Laboratory NAMES (Navy Amphibious Medical Evacuation Simulation) Model was created to assist the Navy Bureau of Medicine and Surgery (BUMED) to analyze and evaluate the effectiveness of multi-echelon combat medical support systems. The Model, which was written in the SIMSCRIPT I.5 simulation language, became operational in September, 1975. It soon displayed its power as a tool for medical contingency planning and also as a research tool. It also demonstrated that standard techniques, developed in World War II, for determining medical personnel and bed requirements are inaccurate. NAMES I, as it was subsequently called, was apparently the first military medical evacuation model to be based completely on logical relationships. In NAMES I, patients died if they did not receive adequate treatment in time;\* they were evacuated from a facility if that facility did not have appropriate medical personnel, or if their anticipated time of confinement exceeded the facility's evacuation policy,\*\* or if the facility's bed capacity was inadequate. No other known model based all of its consequences and actions on logical relationships.

The development of NAMES II in SIMSCRIPT II.5 was undertaken in mid-1976 in order to give the military an even stronger research tool than the first NAMES. The Office of Assistant Secretary of Defense for Health Affairs (OASD (HA)) wanted a model capable of assisting military planners in evaluating various medical regulating procedures so that the procedures finally adopted as policy would be the most efficient medical regulating procedures. This required the model to accept user-specified evacuation procedures, including vehicle loading rules, vehicle destination rules, vehicle unloading rules, and restrictions on the assignment of patients to evacuation vehicles as well as to certain medical treatment facilities. It was decided that the best way to accomplish these objectives would be to develop NAMES II, using the more powerful SIMSCRIPT II.5 simulation language.

NAMES II first became operational on the CDC (Control Data Corporation) 6000 series computer system in December, 1976. It subsequently underwent additional changes in order to incorporate further regulating capabilities requested by the U.S. Army TOMSS (Theater of Operations Medical Support System) Study Group. NAMES II was used in the TOMSS Study and has since been used by the Army Academy of Health Sciences in additional studies. Early in 1978 NAMES II was employed in a pre-exercise analysis of the 1978 Solid Shield Exercise.

In the fall of 1978, NAMES II was expanded in scope beyond its original Combat Zone configuration to encompass the Communications Zone (COMMZ) and the Continental United States (CONUS) as well. The current version of the model, NAMES III, is capable of assisting in the development of wartime medical support planning and patient management all the way from the Forward Edge of the Battle Area (FEBA) to hospitals in CONUS. NAMES III is operable on the CDC CYBERNET (CYBER 175) computer system, the CDC 6000 series computer system, and the Honeywell 6000 series computer system.

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\* All patients in NAMES are alive when they enter the simulated system.

\*\* The period of time which a patient is allowed, by military considerations, to remain at a facility.

The purpose of the Executive Summary is to provide new and prospective users a general overview of the model and its capabilities. Information necessary to effectively use the NAMES III program is contained in the User's Manual, NRL Instruction Book 172. The User's Manual discusses three aspects of the NAMES III simulation program. It first describes the NAMES III Model's medical evacuation system including its inputs and outputs. Secondly, it presents instructions for the use of NAMPRP, a program used to prepare NAMES III input data. Finally, the User's Manual contains instructions for the use of the three computer systems on which NAMES III is currently implemented.



## INTRODUCTION

At the present time the prediction of the capabilities of the medical departments of the Armed Services in wartime is difficult because of the varieties of scenarios that are being considered and because of the complex nature of the medical support systems required to support combat operations. Unfortunately, most models that have been designed to determine contingency requirements have been based on mathematical calculations which do not take into account sufficient detail to include logical inter-relationships that occur in the handling of the combat casualty. These are largely aggregate models. Current contingency requirements models of this type include the U. S. Navy Medical Contingency Planning Model, Phase II (MEDCON II); the Medical Planning Program (MED) of Joint Operation Planning System (JOPS III); and the U. S. Air Force Aeromedical Evacuation and Hospital Bed Requirements Computer Program (AEROMED).

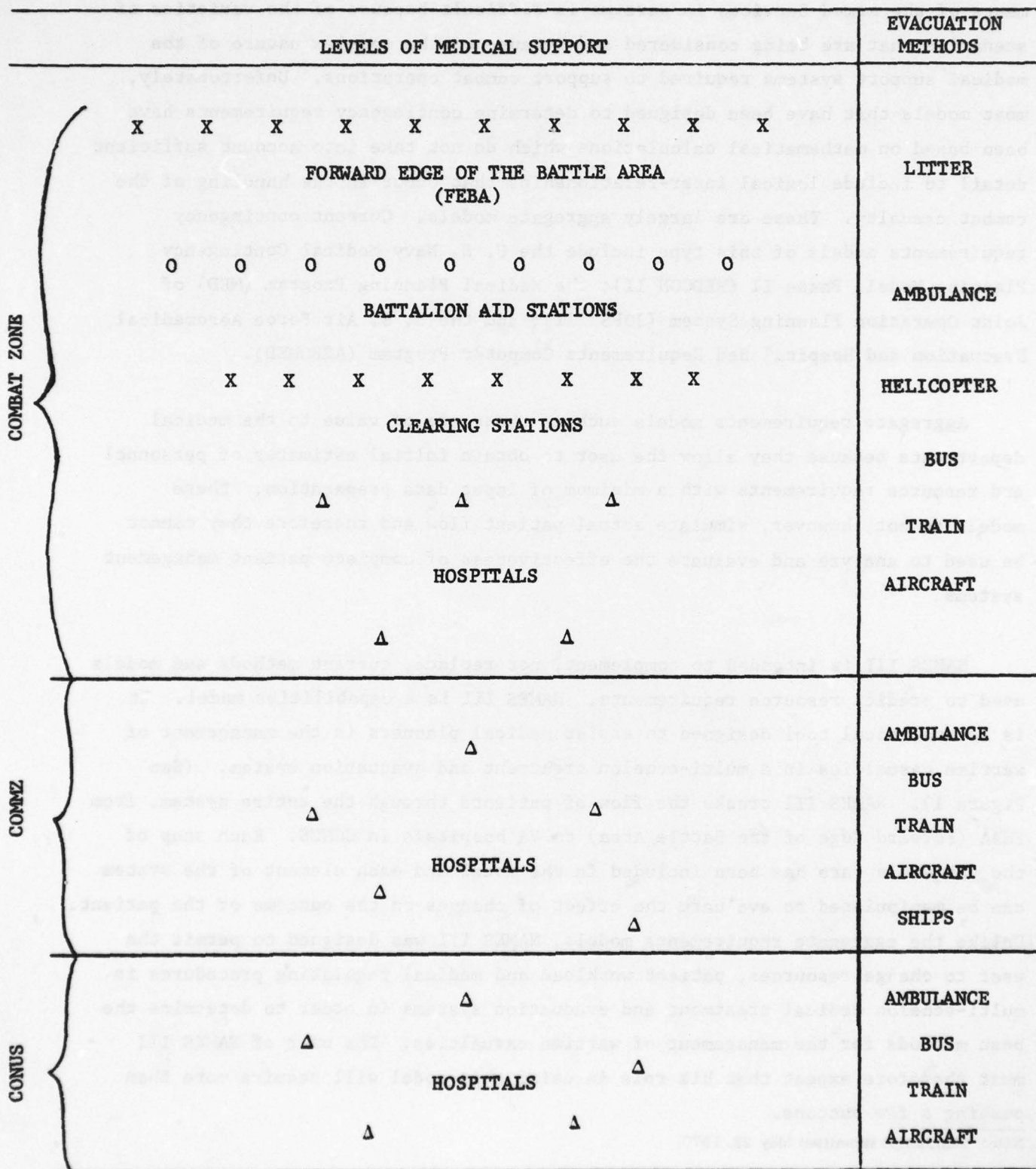
Aggregate requirements models such as these are of value to the medical departments because they allow the user to obtain initial estimates of personnel and resource requirements with a minimum of input data preparation. These models do not, however, simulate actual patient flow and therefore they cannot be used to analyze and evaluate the effectiveness of complete patient management systems.

NAMES III is intended to complement, not replace, current methods and models used to predict resource requirements. NAMES III is a capabilities model. It is an analytical tool designed to assist medical planners in the management of wartime casualties in a multi-echelon treatment and evacuation system. (See Figure 1). NAMES III tracks the flow of patients through the entire system, from FEBA (Forward Edge of the Battle Area) to VA hospitals in CONUS. Each step of the patient's care has been included in the model and each element of the system can be manipulated to evaluate the effect of changes on the outcome of the patient. Unlike the aggregate requirements models, NAMES III was designed to permit the user to change resources, patient workload and medical regulating procedures in multi-echelon medical treatment and evacuation systems in order to determine the best methods for the management of wartime casualties. The user of NAMES III must therefore expect that his role in using this model will require more than pushing a few buttons.

Note: Manuscript submitted May 23, 1979.



# SCHEMATIC OF MULTI-ECHELON MILITARY MEDICAL SUPPORT SYSTEM



### GENERAL DESCRIPTION OF THE NAMES III MODEL

Patients currently enter the system described by NAMES III at any facility level in the Combat Zone (see Figure 1). Patients include WIA's (Wounded in Action) and DNBI's (Diseased and Non-Battle Injuries). The NAMES Model does not consider KIA's (Killed in Action) or MIA's (Missing in Action). The user may include non-combatants in the casualty mix if he so chooses. As each patient enters the system, he is classified according to the nature and severity of his wounds or illness by assigning him to one of a set of user-defined patient classes which encompass all types of anticipated casualties, including outpatients as well as inpatients. The distribution of entering patients over all levels in the Combat Zone is specified by the model user. The user also selects the second facility level to which a patient should go if he must be evacuated from his entry level. This feature allows the user control over the distance a patient will be removed from the FEBA. Casualty receiving facilities may be added or removed at any facility levels or echelons, and additional levels may also be inserted into the model.

The class to which a patient is assigned when he enters the system determines to a large extent his flow through the evacuation chain and his processing at each facility that he enters. Within the Combat Zone, inpatients are assigned one of three priorities: Priority 1, "urgent," indicates that the patient is in critical condition and must receive the most expeditious attention in order to save his life; Priority 2, "immediate," indicates that the patient's condition is very serious and he must be treated without delay; Priority 3, "routine," indicates that the patient is serious enough to require admission to the medical system, but requires no special attention to treat his condition. Outpatients in the Combat Zone are assigned Priority 4, which indicates those patients may wait for treatment until there are no other patients of a higher priority requiring commitment of treater resources.

Each patient's class indicates whether he occupies a litter or ambulatory status (except for outpatients, all of whom are ambulatory), and assigns to the patient an ordered sequence of medical treatments called work units which

the patient must receive before he can recover and ultimately return to duty. The user must specify the work units, in their proper sequence, for each patient class. The user may identify, within this sequence, a Critical Mortality Work Unit. If this work unit is not completed in a time specified by the user, the patient will die. The user may also identify a Critical Convalescent Work Unit. If this work unit is not completed in a time specified by the user, it is assumed that medical complications would ensue and the model accordingly increases the patient's convalescent time by a factor specified by the user. In NAMES III a patient's convalescent time refers to the entire period from the completion of a patient's work units or treatment until his discharge from the medical system to be returned to duty. Thus, in the model, a patient's convalescent time includes his recovery time. For each inpatient the initial convalescent time is selected at random from a probability distribution provided by the user for each patient class. Outpatients have a convalescent time of zero at the time they enter the system; it is increased to one day if they do not receive their Critical Convalescent Work Unit in time.

The user of NAMES III also has the option of identifying for each patient a work unit which should be administered to the patient before he is considered medically capable of withstanding the stress of evacuation. In the current version of NAMES III, this work unit is called the patient's First-Aid Work Unit. (That is inappropriate terminology for such a definitive work unit, and its name will be changed in subsequent versions of the model.\*) Upon completion of this work unit and each subsequent work unit, each patient's convalescent time is compared to the facility evacuation policy, i.e., the period of time which a patient is allowed to remain at the facility. If his convalescent time exceeds the evacuation policy, he will be stabilized for a period of time specified by the user, and then evacuated. Throughout the stabilization period, the patient will continue to receive his required work units, provided appropriate treaters are assigned to the facility. At the end of the stabilization period he will be placed in the evacuation queue, even though

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\* The model's name is also inappropriate at this time, due to the expanded scope it has encompassed since the creation of NAMES I. A new name, more indicative of the model's applicability, will accompany subsequent versions now in development.



he may not have received all of his work units. The purpose of the First-Aid Work Unit is to guarantee that a patient will not be evacuated until it is medically feasible to move him, provided required treaters are assigned to his facility.

For any patient class, the user may choose to identify one particular work unit to be all three of the work units just described. For example, major surgery will be designated for all three for many surgical patients. If the user does not identify any work unit to be one of these three work units, the model assumes that that work unit has already been completed before the patients in that class enter that facility. This means that a patient who has no Critical Mortality Work Unit cannot die no matter how long he waits for treatment; the patient who has no Critical Convalescent Work Unit can experience no possible increase in his convalescent time, contrary to what might be expected from complications caused by delays in receiving certain work units. If a patient has no work unit designated to be completed prior to his evacuation (First-Aid Work Unit), he will be stabilized for evacuation at once if his convalescent time should ever exceed the facility evacuation policy. He will receive, of course, additional work units during his stabilization period if appropriate treaters are assigned to the facility.

The user also has the option of assigning each patient a Mortality Threshold Time. If a patient is so designated, he will die if his initial medical treatment (triage and first aid) at his entry facility is not begun within the designated threshold time. This added feature allows the user to identify and observe those patients who require prompt emergency care, such as respiratory resuscitation or sealing of a sucking chest wound. If a Mortality Threshold Time is not specified for a patient class, the model assumes that the patients in that class need not begin treatment in any specified time, except those times associated with other identified critical work units.

Except for their priority and ambulatory status, and their convalescent times, the attributes of outpatients, including their work units, are assigned according to their patient class as selected by the user. If the user chooses to identify outpatients with patient classes which are associated with inpatients, then those outpatients will have to receive the same work units as the inpatients.



At the medic level (FEBA), all patients undergo triage and receive first aid on a first-in, first-out basis. Inpatients who survive this initial treatment are then evacuated to the rear for further treatment; outpatients are returned to duty. At all facilities except at the medic level, patients are treated on a priority basis with one exception: when a work unit is completed, the patient (without regard to his priority) will receive his next work unit if a treater is available. After undergoing triage and first aid, each patient receives his sequence of work units, provided appropriate treaters are assigned to that facility. The NAMES Model allows flexibility in designating treaters by allowing the user to identify preferred and alternate treaters for each work unit. An expected treatment time is associated with each treater's performance of a particular work unit. If an appropriate treater is not assigned to the facility level, the patient is stabilized and evacuated to the rear. Otherwise the patient continues to receive his ordered sequence of work units.

If a patient is able to receive all of his required work units and if his convalescent time does not exceed the evacuation policy at his facility, he will remain at that facility and return to duty if the convalescent (including recovery) bed capacity is sufficient. Otherwise he will be stabilized and evacuated further to the rear. If a patient enters a facility for convalescence only, triage is not performed. If his convalescent time is within the limits of the facility's evacuation policy and if a bed is available, he remains at this facility for his period of convalescence and is subsequently returned to duty. Otherwise, he is evacuated to the next facility.

Procedures for treating patients in COMMZ and CONUS are generally the same as in the Combat Zone; however, in keeping with standard procedures employed by the Air Force, which has the responsibility for evacuating patients out of the Combat Zone and through COMMZ and CONUS, patients who are evacuated out of the Combat Zone are assigned one of two priorities. If a patient has not received his Critical Mortality Work Unit prior to evacuation from the Combat Zone, he is assigned Priority 1, "urgent." Otherwise, he is assigned Priority 2. All patients leaving the Combat Zone and passing through COMMZ and CONUS are assigned one of these priorities and no others.

One of the features of NAMES III which is considered by current users as a major strength of the Model is the capability of the user to simulate various medical regulating procedures in the management of patients. Any kind of evacuation mode can be employed by the user. The user simply specifies the modes of evacuation he wishes to use at each facility level, the speed and capacity of each type of evacuation vehicle, its home base, the number of such vehicles, whether the vehicle can be requested or operates on a schedule, and finally, the user specifies the priorities of patients which may use certain vehicles as well as the destinations of the various vehicles once they have taken aboard patient loads. These features allow the user great flexibility in examining various medical regulating procedures and their affect on patient mortality, morbidity, and the number returned to duty.

#### ACCOMPLISHMENTS

The NAMES Model has already been used in support of OASD(HA), the U.S. Army Academy of Health Sciences, and the Naval Medical R&D Command to analyze and evaluate concepts and procedures used to provide wartime medical support for multi-echelon structures of medical care and evacuation. Using NAMES, two key factors that affect mortality rates have been identified -- delays associated with administering hands-on medical treatment after the patient arrives at a medical facility; and delays associated with the transportation of patients to the medical facilities in which definitive care is available. Delays in administering medical care depend on treater availability, i.e., the number of times a treater is available to perform a specific task (work unit) at the time the task is required. There is a strong correlation between treater availability and mortality. (Figure 2). Patient mortality does not appear to be strongly related to the capacities of evacuation vehicles; however, the speed of the vehicles, together with the distances between the facilities are important factors which affect mortality rates. (See Figure 3.) Studies with NAMES also indicate that there currently appears to be no feasible alternative to helicopter evacuation in a combat zone unless one accepts a higher mortality rate. (Figures 4 and 5).

Early in 1978, NAMES was used in a pre-exercise analysis of Solid Shield 78. Findings of that study, applicable to most conventional, mid-intensity conflict situations, included the following:

# **VARIATION OF SURGICAL PATIENT MORTALITIES AT HOSPITAL WITH THE AVAILABILITY OF SURGEONS WHEN NEEDED**

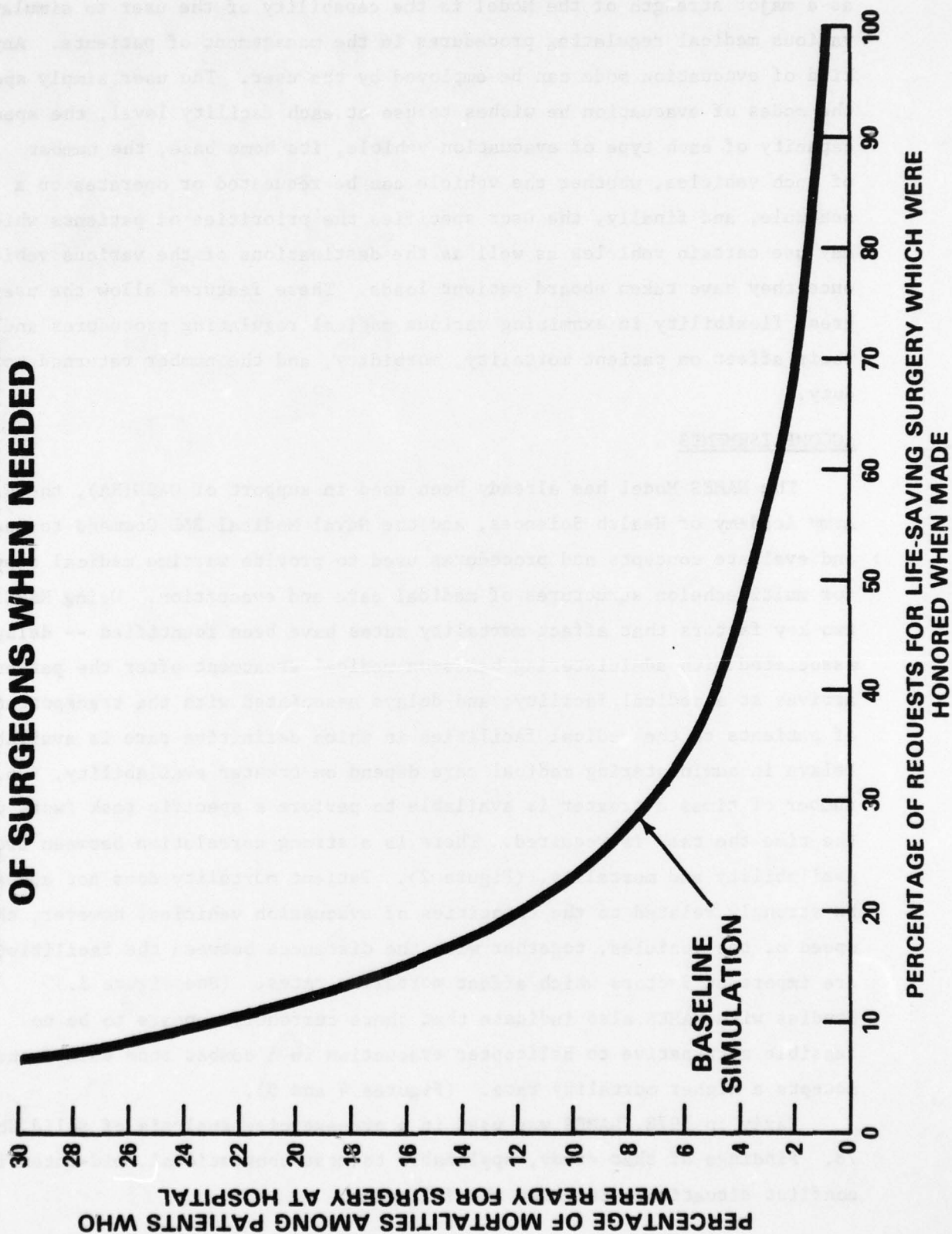
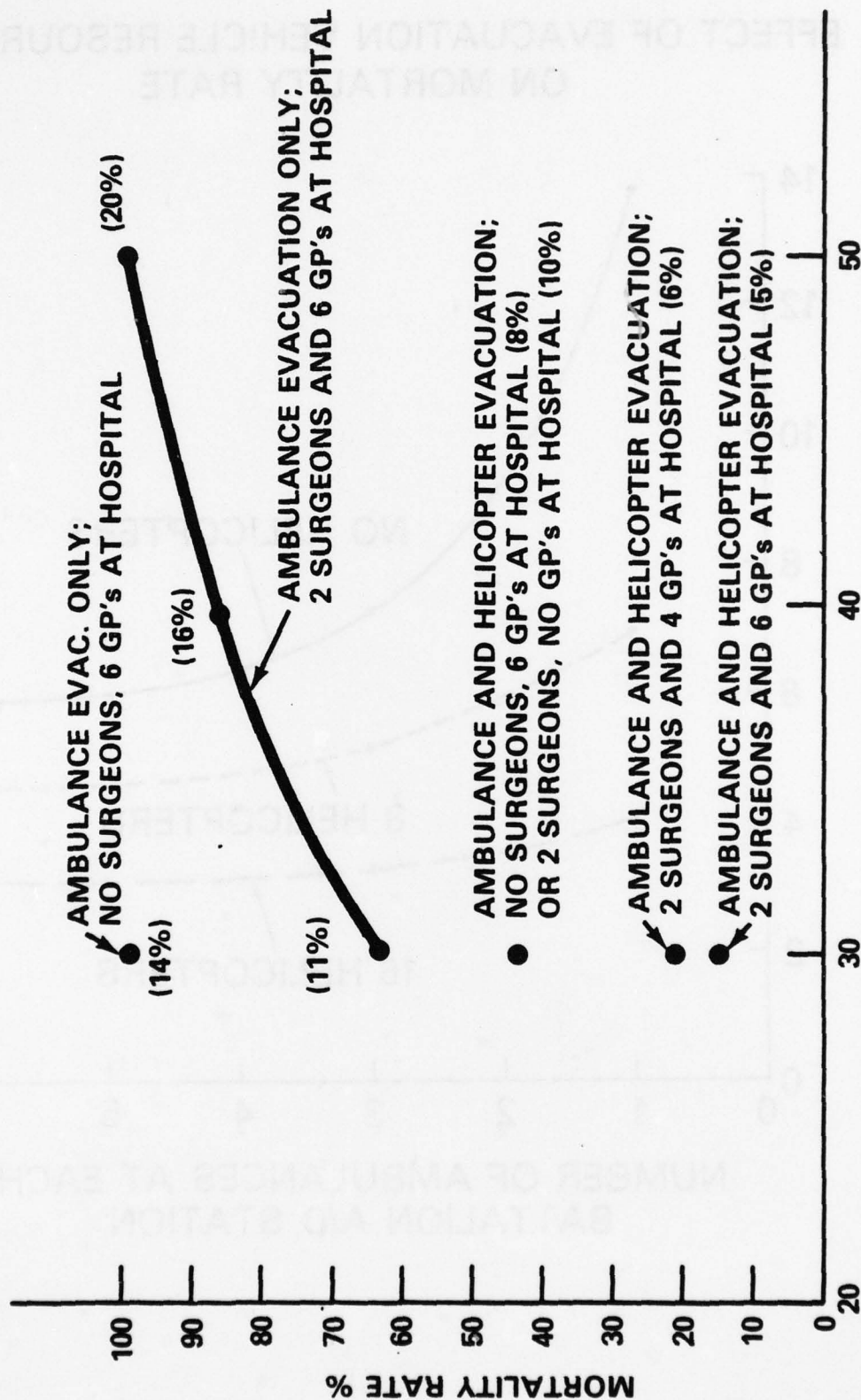


FIG. 2



# **MORTALITY RATES OF PATIENTS WITH SEVERE PENETRATING WOUNDS OF THE THORAX**

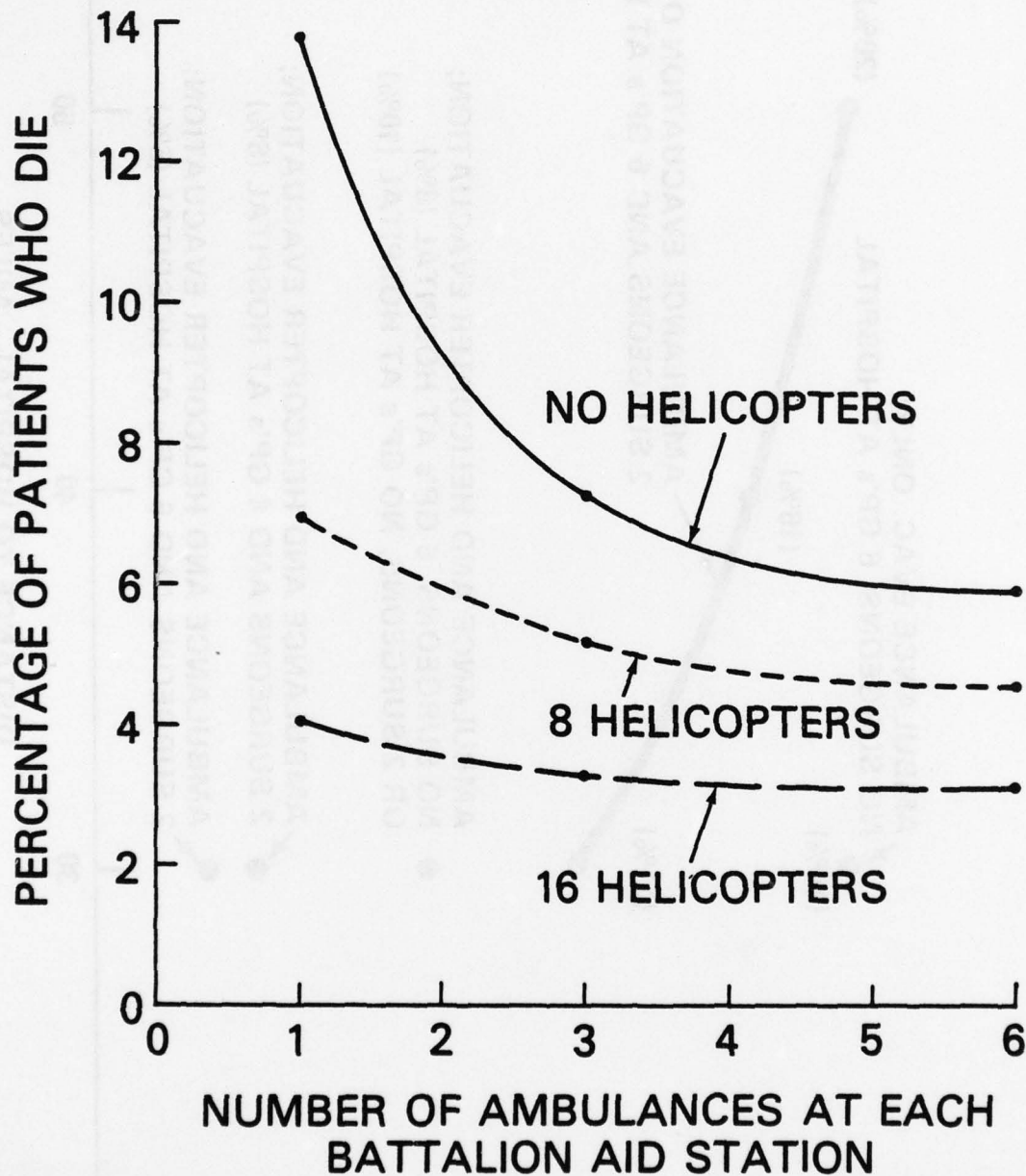


NOTE: NUMBERS IN PARENTHESES INDICATE  
OVERALL MORTALITY RATES

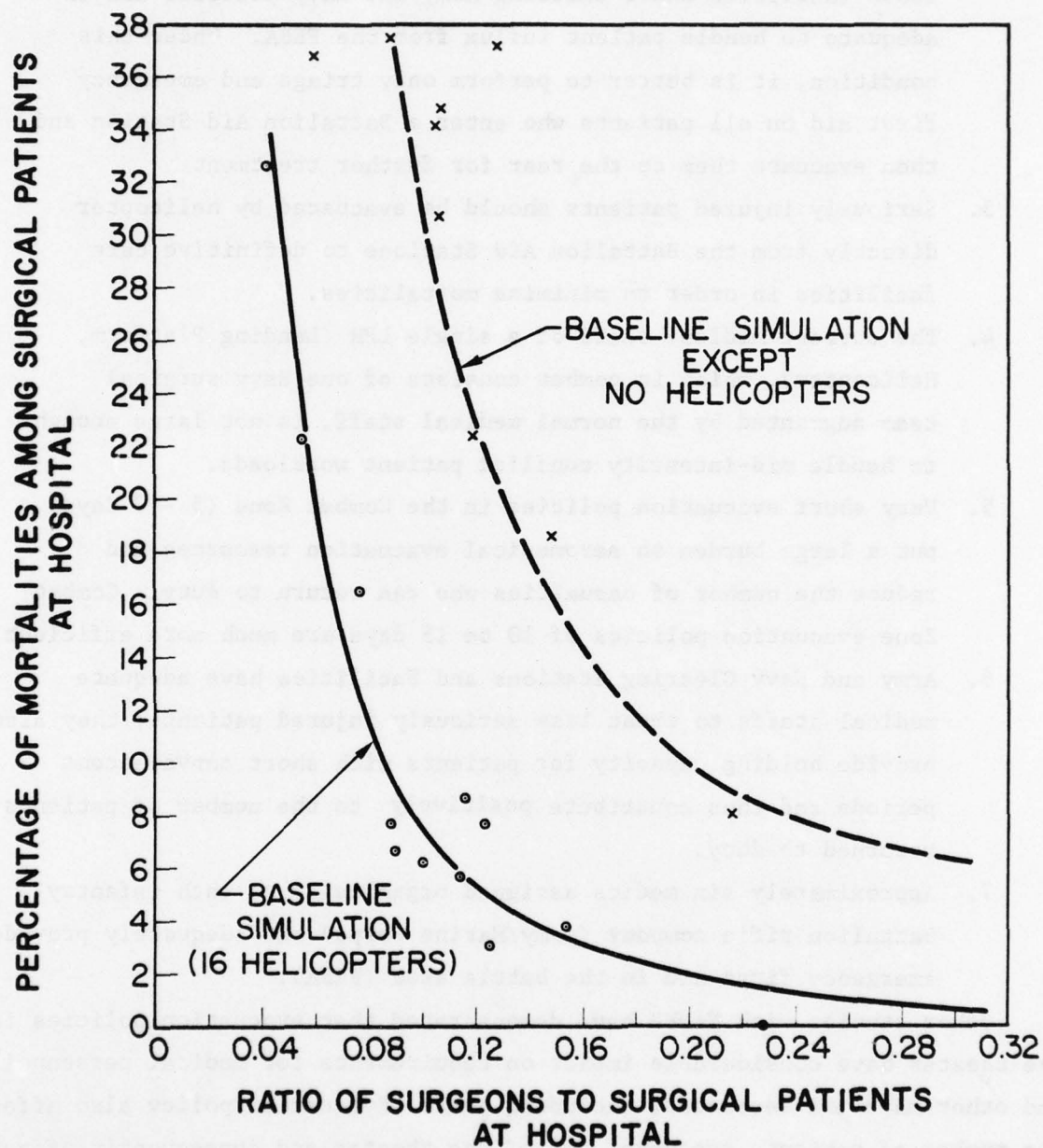
DISTANCE TO HOSPITAL - MILES



## EFFECT OF EVACUATION VEHICLE RESOURCES ON MORTALITY RATE



# VARIATION OF SURGICAL PATIENT MORTALITIES AT HOSPITAL WITH THE NUMBER OF ASSIGNED SURGEONS



1. One ambulance is not sufficient at each Battalion Aid Station to provide prompt evacuation from the FEBA.
2. If helicopters are not allowed to go closer to the FEBA than the Battalion Aid Stations, medical personnel currently assigned to those facilities under existing Army and Navy practice are inadequate to handle patient influx from the FEBA. Under this condition, it is better to perform only triage and emergency first aid on all patients who enter a Battalion Aid Station and then evacuate them to the rear for further treatment.
3. Seriously injured patients should be evacuated by helicopter directly from the Battalion Aid Stations to definitive care facilities in order to minimize mortalities.
4. The current medical staff of a single LPH (Landing Platform, Helicopter), which in combat consists of one Navy surgical team augmented by the normal medical staff, is not large enough to handle mid-intensity conflict patient workloads.
5. Very short evacuation policies in the Combat Zone (5 - 7 days) put a large burden on aeromedical evacuation resources and reduce the number of casualties who can return to duty. Combat Zone evacuation policies of 10 to 15 days are much more efficient.
6. Army and Navy Clearing Stations and Facilities have adequate medical staffs to treat less seriously injured patients; they also provide holding capacity for patients with short convalescent periods and thus contribute positively to the number of patients returned to duty.
7. Approximately six medics assigned organically to each infantry battalion rifle company (Army/Marine Corps) can adequately provide emergency first aid in the battle area (FEBA).

Other studies with NAMES have demonstrated that evacuation policies in the theater have considerable impact on requirements for medical personnel and other materiel resources, including beds. Evacuation policy also affects the number of patients evacuated out of the theater and consequently affects aeromedical evacuation resource requirements and CONUS medical requirements. Studies with NAMES have also demonstrated that increasing the evacuation policy at a medical facility does not necessarily increase the number of patients returned to duty from that facility.



### NAMES III - A METHODOLOGY FOR MILITARY CASUALTY MANAGEMENT

NAMES III gives the medical departments of the Armed Forces an analytical tool with which they can evaluate their capability to perform their wartime functions at a level of detail previously unavailable to them. NAMES III gives each Surgeon General a systems approach which can materially assist him in evaluating alternative concepts and in developing options to accomplish his wartime mission. It will permit each Surgeon General to justify his resource requirements in order to maximize casualty returns to duty. It is a tool that can be used to substantiate or refute arguments for various positions regarding casualty management. It will reduce the uncertainty in the medical planning process. For example, it will tell how many casualties can be processed through a tactical hospital before it becomes a bottleneck. It will also indicate where the bottleneck is in the tactical hospital -- OR's, beds, medical personnel or materiel resources. It will assist in determining which requirements are most important as they affect Services medical support systems. For example, are ASF beds more important than hospital beds? Is DASH-21 equipment more important than comfort pallets? It will show the importance of Civilian Reserve Airlift Force (CRAF) aircraft vis à vis MAC aircraft for distributing casualties within CONUS. It will let each Surgeon General describe his program for casualty management in a functional way. He can use it to evaluate and validate any contemplated change in his medical system. It will give him a stronger basis for making decisions because it will give him numbers which can be used for comparative analysis. Being a simulation model which is based on logical processes, rather than mathematical formulas, NAMES III gives each Surgeon General a perspective of his entire casualty management system which he could not otherwise have. It can also show how the casualty management systems of the three Services would inter-operate.

By using NAMES, the Surgeons General can consider options and concepts to maximize the use of in-theater assets and CONUS assets. This would include plans for the distribution of blood, for the resupply of in-theater medical units, for the pre-positioning of reserve materiel away from high-threat areas, and in the forecasting of resupply requirements. It would include the utilization of maximum aircraft capability for aeromedical evacuation, using military and civilian aircraft, as well as utilization of military and civilian surface transportation, both land and sea.



NAMES could easily include non-combatants in its evacuation plan and could also investigate concepts for evacuation in a chemical warfare environment. NAMES is capable of investigating the effect of theater evacuation policy on in-theater and CONUS medical support resource requirements -- hospitals, physicians, nurses, specialized equipment, etc. -- and on patient mortality and morbidity. NAMES could investigate the effect of premature evacuation on patient mortality and morbidity. NAMES can be used to investigate and evaluate medical regulating concepts to handle large workloads for intertheater, strategic and domestic evacuation. NAMES can also be used to plan in the establishment of priorities for allocation of medical manpower, consistent with theater evacuation policy. NAMES can be used to determine the optimum locations of MASF's and ASF's and can also determine the optimum mix of air evacuation vehicles and in-theater medical support consistent with specified theater evacuation policy. NAMES can relate the team concept to the multiply injured patient and determine the proper number of personnel to handle the patient mix that is anticipated from proposed scenarios. Medically speaking, NAMES can determine the capabilities of present medical facilities or planned facilities and of the number of personnel assigned to handle the patient load. Research has already begun with NAMES to determine the proper roles (number of jobs) that a medical treater should be assigned, depending on the patient mix and the anticipated casualty load.

NAMES has the capability of telling the Services how to make the best use of wartime medical support resources they have been allocated or expect to be allocated. It is capable of telling the Services how to minimize morbidity and mortality and how to maximize returns to duty.

#### UTILIZATION OF NAMES AND ITS COST

NAMES is the only model known to have the capability to perform an analysis similar to the Solid Shield 78 pre-exercise analysis performed early in 1978. That analysis cost the Government considerably less than \$20,000 in labor and less than \$1,000 in computer usage. (Fewer than 20 simulations were performed using NAMES, at a cost of approximately \$40 per simulation.) The manpower included preparation of the data and analysis of the simulations leading to publication of the OASD Report "Combat Medical Support: Lessons Learned From Pre-Exercise Analysis of Solid Shield 78." This report describes significant

conclusions reached through NAMES regarding optimum medical regulating procedures, the use of Landing Platform, Helicopters (LPH) and the disposition of resources and medical personnel in combat zone evacuation systems. These results could not have been obtained with current requirements models.

Compared to these costs associated with the use of NAMES in Solid Shield 78, consider what the cost to the Government would have been had medical personnel and resources actually participated in the exercise, together with the 28,000 men and women from the Army, the Navy, the Marine Corps and the Air Force who participated in the combat scenarios associated with Solid Shield 78.

The actual cost of running NAMES, its computer memory requirements, and the complexity of the model obviously depend upon the medical system being simulated and the computer system being utilized. Most work with NAMES in the Washington, D.C. Area is currently being performed on the CDC CYBERNET (CYBER 175 computer) system. This is a commercial system which offers a large discount to DOD users. A typical simulation of 15 combat days during which patients are tracked from the FEBA through the Combat Zone, through COMMZ and through CONUS requires about 80 seconds execution time on the central processor (CP), uses around 200,000 octal (about 80,000 decimal) words of memory in the computer core, and costs about \$45. These simulations typically have work loads to be found in a mid-to high-intensity conflict involving in excess of 20,000 ground combat troops.

Several steps are being taken to make NAMES easier for a non-programmer user to manipulate and also to allow the user to simulate larger medical systems. A pre-processor FORTRAN program has been developed to aid the non-programmer user in the preparation of input data for NAMES. This program will ask the user to submit input data in the proper format and will correct him if he makes an error. For most of the input data, such as medical data, which the user does not care to alter from one simulation to another, the pre-processor program will pre-record different sets of "default" input data, and if the user is willing to accept one of these sets intact, the user has nothing to do but indicate this. The user may even accept most of such a set, and make minor modifications himself, under the tutelage of the pre-processor program. This program is expected to reduce much of the work associated with the complex input data which NAMES must have if it is to simulate real-world situations.

During the coming months, modifications will be made in NAMES so that it can be run in modular form. For example, if the user wants to simulate 12 divisions with different patient work loads, different evacuation configurations and different resources, each feeding into one COMMZ, which in turn feeds into CONUS, then one, two or several of the combat zone systems can be analyzed separately, with output data consisting of the number and type of patients being evacuated out of the combat zone via tactical medical evacuation aircraft. The next step would be to use this output information as deterministic input data in a simulation which would model patient flow into and through COMMZ and on into and through CONUS. This modular construction and operation of NAMES will serve two purposes: (1) it will permit maximum use of computer memory space, and (2) it will permit the user to focus on a particular zone of a world-wide military medical support system in more detail than he may care to examine another zone. This approach will also have cost benefits.